Optimized Communications for Smart Metering & Smart Grid

Prof. Dr.-Ing. Axel Sikora

Fakultät Elektrotechnik und Informationstechnik (E+I)

Badstraße 24
77652 Offenburg
Tel. 0781 205-4 16
E-Mail: axel.sikora@hs-offenburg.de

1966: geboren
1988 – 1993: Studium der Elektrotechnik an der RWTH Aachen
1993 – 1995: Wirtschaftswissenschaftliches Zusatzstudium an der RWTH Aachen
1993 – 1996: Wissenschaftlicher Mitarbeiter am Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme in Duisburg
1997: Promotion über den Entwurf digitaler Schaltungen für den Einsatz in der Hochtemperaturelektronik unter Nutzung von SOI-Technologien
1996 – 1999: verschiedene Tätigkeit in der Telekommunikation und der Halbleiterindustrie; zuletzt als Group Leader Product Support System LSI Products bei NEC Electronics (Europe) in Düsseldorf.
1999: Berufung als Professor an der Berufsakademie Lörrach
Seit 2002: Gründung und Leitung des Steinbeis Transferzentrums für Embedded Design und Networking, das bis heute etwa 200 F&E-Projekte im thematischen Umfeld der drahtlosen und drahtgebundenen Netzwerke bearbeitet hat.
Seit Sep. 2011: Professur für Embedded Systeme und Kommunikationselektronik an der Hochschule Offenburg
Forschungsschwerpunkte: Entwurf, Simulation und Implementierung von Kommunikationslösungen unter Nutzung von Eingebetteten Systeme. Ein thematischer Schwerpunkt hierbei sind auch Smart-Metering-Anwendungen

1.5 Optimized Communications for Smart Metering & Smart Grid

Prof. Dr.-Ing. Axel Sikora
Dipl.-Ing. Dipl.-Wirt.-Ing.

Abstrakt

Schon seit Jahrzehnten werden Patienten mit elektronischen Sensoren überwacht. Die drahtlose Anbindung der medizinischen Sensoren wird eine deutlich höhere Flexibilität ermöglichen, weil das Monitoring der Patienten unabhängig vom Ort und der Tätigkeit durchgeführt werden kann. Auf diese Weise werden sogenannte Tele-Health- und Tele-Monitoring-Anwendungen einen ganz neuen Markt ermöglichen. Dabei differenziert man typischerweise eine lokale Kommunikationsebene im unmittelbaren Umfeld des Körpers (sogenannte Wireless Body Area Networks, WBAN) und eine Weitverkehrsebene.

Das Buch führt in aktuell verwendete WBAN-Technologien ein und gibt einen Überblick über die wichtigsten Herausforderungen bei der Entwicklung und dem Betrieb solcher Systeme.

Das Kapitel von A. Sikora diskutiert hierbei insbesondere die Koexistenzproblematik solcher Netzwerke mit anderen Funksystemen in gleichen oder benachbarten Frequenzbereichen.

Abstract

Home Automation, Smart Metering, reduction of energy consumption for climate preservation – those buzz words are flooding the daily press.

The European Directive 2006/32/EC (Energy-Use Efficiency and Energy Services) commits its members to reduce their energy consumption about nine percent from 1996 to 2015, and supports smart metering and the need of new developments for encouraging energy efficiency and CO^2 reduction in households and commercial buildings. The European countries have started different projects to achieve this goal. Also outside Europe, smart metering gains interest, for energy savings and better distribution network control.

A plethora of activities from water, gas, heat, and electricity utilities is ongoing to achieve this objective. Communication is in the middle of interest within these activities. Communication applies to all levels – from primary level between meter and data collector to backend interconnectivity.

The paper gives an overview on various national and European projects that the author's team is involved in. The latest one is dubbed WiMBex and is performed within the University of Applied Sciences, Offenburg.

Introduction

Reduction of energy consumption has become a major political goal, and nowadays, green technology is a motor for the economy. The measures to save resources are manifold, and some of them, e.g. green fuel, show a disputable ecobalance once they are widely used. But the political intention is unambiguous to stop the global warming.

In 2006, the EU passed the Energy Services Directive (ESD) 2006/32/EG [1], which commits its members to reduce their energy consumption about nine per cent from 1996 to 2015. According to the EU energy blueprint [2], the EU's greenhouse gas emissions are to be reduced by 20% in 2020 compared with 1990 levels. Furthermore, the Energy Efficiency of Buildings Directive [3] requests the energy monitoring, certification and minimum standards on the energy performance of new buildings. In Germany, starting from 2010, all new buildings are to be equipped with meter devices that monitor the current energy consumption for the consumer [18] (smart meters), and up to 2020, 80% of the buildings shall be equipped with smart meters.

Once, such a communication solution will be available, additional functionalities for Smart Home or Home Automation can be supported, i.e.:

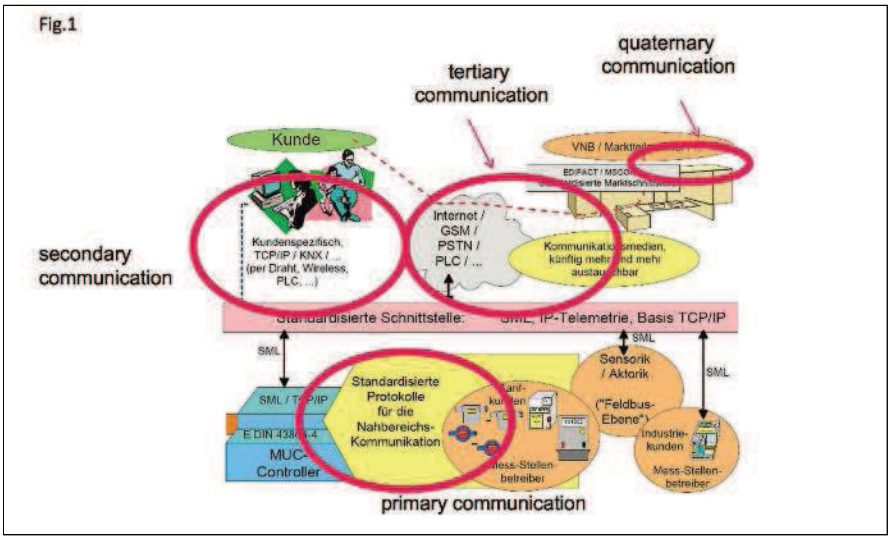

Fig. 1.5-1: *Four Architectural Levels of a Typical Smart Meter Network [4]*

remote control of (distributed) energy suppliers, such as photo-voltaic (PV) systems, combined heat and power (CHP) units, or alikeremote control of larger energy consumers, such as HVAC-units, washing-machines, charging stations for electric vehicles

Network Architectures & Requirements

The typical metering infrastructure can be classified into four categories [4], as shown in Figure 1.5-1.

- primary communication (Local Metrological Network, LMN). between a local sensor or actuator and a data collector / gateway
- secondary communication (Home Area Network, HAN), which allows the local monitoring of data and events at the customer premises
- tertiary communication (Wide Area Network, WAN) between the data collector / gateway and the provider of the functionality (utility)
- quarternary communication between the utility and other market players

The main technological interest is in the first three layers, which combine the most critical requirements:

- ultra-low energy consumption: Especially for battery-based or energy autarkic applications, like in gas or water meters or other distributed sensors, the lifetime of the energy reservoir must be larger than the replacement or recalibration interval, i.e. eight or more years
- high stability and scalability: Although the complexity of each single node is not very high, the size of the complete smart metering networks might be in the range of some tens of thousands of nodes. Ease of commissioning, stability of operation, and efficient network monitoring solutions are required
- interoperability: It is clear that the products for these large networks will be delivered from multiple vendors, which necessitates interoperability of communication protocols and of interfaces. Standardization and extensions to support custumized solutions have to be balanced
- security: Security with regard to network communication includes aspects like confidentiality, authentication, authorization, integrity, and non-repudiation. Efficient cryptography and secure protocols are required
- cost: Especially residential meters are extremely price-sensitive, so all these functionalities must be enabled at minimum cost

DEMAX: Decentralized Energy & Network Management with Flexible Pricing

The DEMAX project followed the objective of distributed measurement and control of energy consumption and production at the individual residential household level. For this, legacy tertiary communication techniques are used for the data exchange between premises and energy providers. For the in-house primary communication, the metering bus (M-Bus and its derivative Wireless M-Bus) is used which is specified for reading out data from various metering devices like water, gas, heat, electricity and alike.

The DEMAX project was performed within the innonet program between 2007 and 2010. It was supported by German Ministery of Economics and Technology with a total project budget of roughly 1.3 Mio €.

The project partners included the whole value chain from research institutions, meter manufacturers, CHP manufacturer, energy supplier, and energy broker, i.e. Fraunhofer Institute Solar Energy Systems, Steinbeis Innovation Center Embedded Design and Networking, Elektrizitätswerke Schönau GmbH (EWS), in.power GmbH, Görlitz AG, SSV Software Systems GmbH, and SenerTec Kraft-Wärme-Energiesysteme GmbH.

ME³GAS: Smart Gas Meters & Middleware for Energy Efficient Embedded Services

ME³GAS (pronounce: 'migas) is the acronym for MEEEGAS, which again is an acronym built from the full project title Smart Gas Meters & Middleware for Energy Efficient Embedded Services. The objective of the ME³GAS project is to put consumers in control of their energy efficiency and appliances at home.

In this context, ME³GAS project addresses the development of a new generation of smart gas meters, based on embedded electronics, communications and the remote management of a shut-off valve, which shall offer a whole range of added values: management of multiple tariffs and payment modalities, remote gas cut off, security alarms, absolute index, temperature correction, and alike. Specification, implementation and dissemination of an open architecture for wireless communication shall also be addressed in the project. The utilization of intelligent concepts is what makes energy smart, and is the heart of energy-efficient technologies. Through energy-intelligent control, regulation and communication further improvements in energy yield are expected.

The ME^{3}GAS project is partly funded by the ARTEMIS-JU (Call 2009) and by the participating Member States under contract number 100266. It covers two of the three horizontal technology layers, i.e. Reference Design and Architectures (RDA), and Seamless Connectivity and Middleware (SCM). The project period is from May 2010 till Apr 2013 with a total project budget of around 15.7 Mio €.

The ME^{3}GAS consortium unites 15 partners from six European countries. It covers a large part of the energy provision value chain. Participating partners include gas utilities, manufacturers of gas meters and metrology services, developers of middleware systems, and research institutes.

Main project partners for the communication part of the project are Gas Natural SDG. S.A (Spain), Kromschroeder S.A. (Spain), Societa Italiana per il Gas P.A. (ITALGAS, Italy), Itron Deutschland (Germany), Elster GmbH (Germany), Steinbeis Innovation Centre for Embedded Design and Networking (Germany), and Sistemas Avanzados de Control (SAC, Spain).

Further information can be found at http://www.me3gas.eu.

Remote Wireless Water Meter Reading Solution Based on the EN13757 Standard, Providing High Autonomy, Interoperability and Range

The European Standard EN 13757 "Communication systems for meters and remote reading of meters" defines a Wireless Metering Bus, which is commonly referred to as "Wireless M-Bus", or "WiMBus". The Wireless M-Bus is an open standard, specifically designed for the needs of EU utility companies for the remote metering of electricity, gas, heat, and water usage.

The aim of the WiMBex project is to add a powerful new set of new features to the Wireless M-Bus platforms developed by the consortium SMEs, to enable them to keep pace, and even surpass the needs of the emergent Automatic Water Meter Reading (AWMR) market in Europe.

WiMBex will exploit powerful new features of the EN 13757 Wireless M-Bus standard, and in this manner, extend the use and impact of the European standard.

Fig. 1.5-2:
CAPT2WEB
generic gateway platform for monitoring and commissioning of smart meter gateways

The total project period is from Dec 2011 till Nov 2013 with a total project budget of around 1.5 Mio €. It is funded by the EU within the 7th Framework Program FP7-SME-2011 Activity 2.1 Call 4.

Project partners include Centre de Recerca i Investigació de Catalunya (CRIC, Spain), Lowri Beck Systems Ltd. (UK), Ossidian Technologies Ltd. (Ireland), CASON Engineering Plc. (Hungary), Tritech Technology AB (Sweden), JCB Electromecanica (Spain), Hahn-Schickard-Institut für Mikro und Informationstechnik (HSG-IMIT, Germany), Meath Hill Water Services (Ireland) and University of Applied Sciences Offenburg.

Further information can be found at http://wimbex.com/

Outlook

Further activities in the field of smart metering of the author's team is performed around:

- the standardization in the Open Metering Specification (OMS) in the ZVEI [5], which has found widespread significance in the field
- the development of secure and flexible tool platforms, such as shown in Figure 1.5-2. For example, this platform allows the interfacing between tertiary HTTP-XML-based communication (over Ethernet or GPRS) with various primary communication protocols (Wireless M-Bus, ZigBee, EnOcean Radio Protocol, and others)
- the security solutions the Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik, BSI) is working on a Technical Directive 03109 for the "Secure Implementation of Intelligent Measurement Systems" [0], which is on its way to become a model description for many other European countries

References

[1] http://eur-lex.europa.eu/ LexUriServ/ LexUriServ.do? uri=OJ:L:2006:114:0064:0064: EN:PDF

[2] http://www.euractiv.com/en/ energy/ eu-energy-blueprint-putsonus-climate-change-renewables/article-160805#

[3] http://europa.eu/legislation_ summaries/ energy/ energy_efficiency/ l27042_en.htm

[4] Lastenheft MUC (Multi Utility Communication), Forum Netztechnik/ Netzbetrieb im VDE (FNN), ver. 1.0, ed. 5. Aug. 2009, http://www.vde.de/de/fnn/arbeitsgebiete/ messwesen/documents/FNN_LH-MUC_1-0_2009-08-05.pdf

[5] http://www.oms-group.org/

[6] https://www.bsi.bund.de/DE/ Themen/SmartMeter/ TechnRichtlinie/TR_node.html